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Dual Economic Development and Degradation of Ecological Environment of Lancang River Basin

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Abstract

The development of Lancang River basin has shown the dual structure in that the major development efforts have been paid to the big economic infrastructure projects and mining plants from which the local rural communities can not get the most benefit. Therefore, although substantial resources have been invested in this region, the well understood vicious poverty and degradation of natural resources cycle can not be broken. Meanwhile, the construction and operation of these infrastructures and mining industries adds new risks to the natural environment. Without preventive and proactive polices and strategies, degradation of natural resources, which in turn will impact on the life expectancies and utilization rate of the infrastructures, will be intensified. A qualitative system dynamics model, focusing on feedback analysis is built to analyzes the effectiveness of the implemented and proposed development strategies in Lancang River Basin.

Key Words: Lancang River Basin; dual structure; development policies and strategies; degradation of natural resources; system dynamics model; feedback analysis

1. Problem identification:

The normal total proposed planning area in Lancang River Basin is around 142,000 km2, which accounts for 37.2% of Yunnan Province. The total population in the basin was 9.60 million in 1997, which was 23.5% of the total provincial population. There are 18 minorities in this basin. In 1992, there were 4.698 million minorities in the basin, which was 47.65% of the basin's population of that year. In 1994, there were 592 countries which were categorized as the poorest counties in the country, 22 counties in the Lancang River Basin fell into this category.

Lancang River is rich in water resource. The average water resource per capita is 110,000 M^3, which is 1.6 times of the average provincial level. The potential electricity capacity is 22.74 million kW. The good geographic locations for these potential hydro-power stations make the hydro-energy the cheapest energy supply in

the region. The area is also rich in mineral resources, especially in lead, zinc, copper and tin. The lower basin of Lancang River Basin is the second largest forestry base of Yunnan Province, one of the four forestry bases in China. The lower basin of the river accommodates the most valuable tropical vegetation in China. The well preserved natural environment attracts the tourists in this region.

1.1. Natural resource based development patterns

The development of Lancang River Basin has been based on the exploitation of the natural resources due to their richness. The traditional local economy also depends on the natural resources. The agricultural sector is the dominant sector in terms of both employment and value of production. In 1992, there were 8.966 million people in the agricultural sector, about 90% of the total population in the region. Compared with the average level across Yunnan province, the industrial and construction sector is very poorly developed. However, service sector has been developing more rapidly than average at the Yunnan provincial level, especially in the tourist sector. Following the development strategy of Lancang River, major attention has been given to the construction of large infrastructure and industrial plants.
In 1985, Middle Basin of the Lancang River was identified as one of the major national development areas for hydro-power and black mineral resources. Following on this, the Yunnan Provincial Government has set the development of the Lancang River Basin as the basic strategy for the development of Yunnan Province.

The construction of Manwan hydro-power station began in 1986 and the first operation started in 1993. The total capacity is 1.35 million KW. The construction of Da Cao Shan hydro-power began in 1997 and the first stage operation is expected in 2001. The total capacity is 1.35 million KW. Xiaowan hydro-power station is under preparation. The construction of the high standard road from Cu Xiong to Dali loaned by ADB was initiated in 1996 and finished by 1998. Si Mao, Jing Hong and Guan Lei ports were completed during 1990s. The Lanping Lead mining and processing factory were established in early 90s and the construction of Simao paper mill loaned by ADB started to produce in 1996.

These development strategies have already led to the rapid economic development in this region. However, the ecological environment has been degrading. The ecological degradation is perceived to be very serious. Soil erosion, degradation of grassland and the reduction of the bio-diversity are perceived to be the most serious issues in Lancang River Basin although the forest cover in this region is higher than the average level across Yunnan Province.

1.2. Degrading natural environment

The generic vicious cycle between the poverty, population pressure and the degradation of ecological environment is especially applicable in this region where steep mountains account for majority of the land areas (Table 1).

Table 1 land distribution patterns

Slope of land	**Percentage of land areas**
<=8	4.78%
between 8-15	8.25%
between 15-25	44.57%
>25	42.7%

(Data source Yunnan Environmental Commission 1997)

Yet, the newly development has brought new risks to environmental degradation and depletion of natural resources. According to the research done by Yunnan Environmental Commission (1997), the resources based development strategies in the past have brought substantial environmental changes in Lancang River Region. The most seriously ecological damaged area is in the middle basin of the Lancang River where most of the development projects have been implemented, such as the construction of paper mill at Simao and the construction of two hydro-power stations, are located.

The building of large dams and the construction of the hydro-power stations can lead to positive and negative environmental and social changes of the river basin. The excavation and processing of mineral resources, one of the major development strategies, discharge of the wastewater, air pollution and solid wastes into the river basin. Tourism also can bring the negative environmental impacts on the Lancang River basin. Development of infrastructures for tourism and the activities of tourists directly threat the ecological environment. The exploitation of bio-resources, one of the major development strategies, is manifest in agro-industries as the biggest polluting industry sector in the region. For example, sugar and paper mills are the two largest polluting sources in the region.

2. Duality of the development strategies

It can be argued that adopted development policies and strategies can promote the regional economic growth and increase the income of the rural people by providing infrastructure service in the region, creating employment opportunities in infrastructure construction and in mining industries. The developed economy can break the vicious cycle and stop further environmental degradation. Yet, the development strategies failed to achieve the expected patterns due to the duality of infrastructure services and duality of mining industries embodied in the dual structure between rural and urban sector and between the local majorities and external investors.

2.1. Dual access to infrastructures

Many researchers have pointed out that one reason for the inefficiency of infrastructure investment is the lack of attention paid to accessibility of the infrastructure (Howe and Zille 1987; Barwell et al. 1985; ILO 1998 a and b). A focus on access is important, as it is a common theme which can be applied to all types of rural infrastructure (ILO 1998). As suggested by Eberts and Biehl (1986), Nadiri and Mamuneas (1994), the stock of public capital must be adjusted by an appropriate index to demonstrate the degree of usage by the producers. ILO (1998 a and b) points out that heavy investment in roads may in any case not be the only — or even a priority — solution to the problem of access. Few rural people in developing countries either own a motor vehicle or can afford to pay for motorized transport services. Therefore, the accessibility, defined as the ability to reach, visit or use is more important to the peasant or small producers.

In this region, Lancang river is running deep in the valleys and thus water resources are difficult to be accessed for drinking and irrigation. In the early 90th, about 3rd of the population in the River Basin could not get access to drinking water. Irrigated cultivated land was only a small percentage of the total cultivated land. Although large hydro-dams have been built, the energy sources for the rural areas still depend on the woodfuel because of the transmission network has not been built up and the majority of the rural people can not afford to use electricity. Yet, more than 50% of the rural people in this region, who are facing the shortage of woodfuel, have brought damages on the forestry and grassland. The rural roads have been built by raising the local money. Although the statistical data shows that the construction of Xiang to Xiang roads have been dramatically increased in recent years, the quality of these roads are extremely poor and most of them can only accessible during the dry seasons.

2.2. Dual technological level

Mining companies in this region have no real connections with the local regions. The mining companies normally only need to employ semi-skilled or unskilled workers from the local rears. The development of human resources in the mining industrial is very slow and the kills developed in mining industries are very specialized. The workers who are employed in the mining usually will have difficulties to get another job once the extraction of the resources finishes. Environmental registration usually forces the companies to use modern technologies to clean the pollution. As the result, the companies are not under direct pressure to acquire local knowledge or expertise about the environment. The local community may only experience a short-term economic boom but end with a huge area of waste land. Similar development patterns have been observed in the mining industries in Ireland.

Any policies which neglect this dual structure give unexpected results as has been borne out by experience. Due to the duality, not only regional economy can not developed in a balance way, the effectiveness of the formal infrastructure and industrial projects can hardly be achieved in this duality.

The degradation of the ecological environmental has shown its feedback on economic growth in this region. For example, ADB loaned the paper mill project at Ximao in the lower basin in 1996. It was expected that the surrounding forestry can guarantee the raw material supply. Now the consumption rate of forestry in that region is beyond the regeneration rate. The paper mill has been facing the shortage of raw material supply.

3. Feedback and dynamic analysis of the effectiveness of the development strategies

We also feel that the major problem of the formerly formulated development strategies was due to the lack of a systematic and dynamic perspective. For example, because of the lack of a systematic analysis, the impact of the poverty of local community on big infrastructures has not been adequately considered. The degradation of natural environment shortens the effective life expectancies of hydro-dams and transportation infrastructure. Dynamic perspective is extremely important in policy analysis regarding infrastructure construction and natural resources degradation. Infrastructure usually involves a long delay in planning, construction and in service. It takes a long time for the investors and regulators and consumers to see the effectiveness of infrastructure investment (Xu 1999). The degrading of the natural resources is more difficult to be perceived because there is a lack of effective monitoring system. There is usually no definite criterion for evaluation of natural system which usually leads to an eroding target for protection of natural system.

A formal system dynamic model can help to understand existing structure of the development in the Lancang river basin and to effectively improve policy and strategy formulations which requires the explanation of the occurrence and changes in system behavioral patterns over the long run. The procedures for building a system dynamics model requires the explanation of the system behavior based on the model's structure. A system dynamics model has two important aspects: (1) feedback structure emphasizing the circular causal linkages of system elements, and (2) dynamic behavior (Forrester 1961).

A simplified version of system dynamic model of development of Lancang River basin is illustrated in figure 1, the structure of which forms a web of causal connections. The causal connections are denoted by the arrows that tend to ``feed back" on themselves forming circular loops. Both causal connections and feedback loops have polarities. A plus sign next to a causal arrow denotes change in the same direction while a minus sign indicates an inverse relationship. There are two kinds of

feedback loops, positive feedback loop and negative feedback loop. A growth feedback loop is positive if it contains an even number of negative links. A positive feedback usually represents a growth behavior. A growth feedback loop is positive if it contains an odd number of negative links. A negative feedback usually represents a constraints to growth. Figure 1 is composed with four major feedback loops, three positive feedback loops and one negative feedback loop.

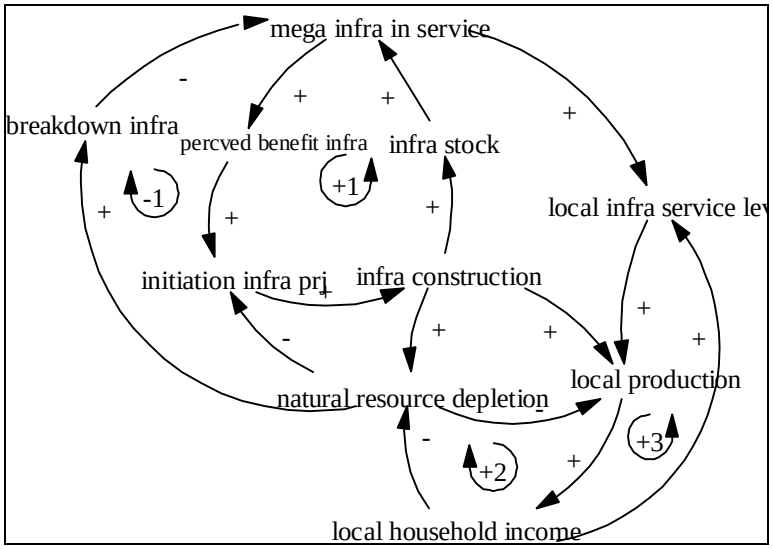

Figure 1 Feedback loops of development in the Lancang River basin

The feedback 1 represents the rationale behind the construction of big infrastructure projects. This feedback loop is a positive feedback loop indicating a growth pattern or a declining pattern. When more infrastructure projects are initiated, constructed and put into services, more economic benefits can be obtained from the construction of the infrastructure projects. The economic benefits include two parts: direct financial revenue and the induced regional economic growth by an increased availability of infrastructure services. Financial revenue consists of the sales of electricity to Thailand, other province of Yunnan and the rest of Yunnan, user charges of the road and of navigation on Lancang River. This growth feedback loop is constrained by a negative feedback loop –1 which illustrates the impacts of degradation of natural resources on construction of formal economic infrastructure in the long run. When more infrastructures are built, more natural areas are turned into construction areas. Since Lancang river basin is mountainous area. The degrading natural environment can lead to an increase of natural disasters and soil erosions. Therefore, the effectiveness of infrastructure services is reduced due to shortened live expectancies and reduced infrastructure utilization rate.

However, since the initiation and construction of infrastructure projects usually involve long time delay, therefore, the actual economic benefits from construction of

large infrastructure can only be perceived after a long delay and actions to manage optimal infrastructure start up rates are further delayed. Meanwhile, the impacts of the degrading of the natural environment on the effectiveness of infrastructure are also difficult to be perceived and understood until the negative impacts become very serious. Actions are taken to reduce the infrastructure construction. Since the time delays of the two feedback loops are different and all involve long delays, over reactive actions for the stakeholders to manage the initiation of infrastructures frequently occur. In the long run, it can be perceived that infrastructure either turns into a bottleneck for the regional economy or proves a waste. Therefore, without a systematic approach to include the negative feedback between natural environment and infrastructure construction, proactive and long-term effective infrastructure policies and strategies can not be formulated.

Yet, operation strategies to prevent the degradation of natural environmental can not only limit to the impacts of infrastructure construction. The leading factor in Lancang River region for environmental degradation is poverty. Feedback 2 is the well-observed vicious cycle between natural environment and the natural resource based local economy in the long run. When the local economy is performing well, depletion of the natural resource will be reduced. Rich natural resources in turn increase the potential for further economic growth. However, when economy is performing badly and majority of people fall into poverty, people have to rely on the extensive exploitation of the natural resources and their financial capacity for rehabilitation of the environmental is poor. The natural environmental is degrading in the face of poverty.

Feedback 3 explains the potential for using infrastructure as a policy tool to break the vicious cycle. When the local economic growth is obtained, more financial resources can be raised by local communities to build small scale local infrastructures and to connect to the formal infrastructure networks. Therefore, the accessibility to available infrastructure increases and the economy further grows.

Large part of Lancang River basin is trapped in this vicious cycle. The local economy and local infrastructure services stay stable at low levels. Therefore, the two re-enforcing feedback loops interact with each other and make many policies ineffective.

4. Policy analysis

When the development strategies by prioritizing infrastructure have been implemented, a substantial amount of resources has been invested in this area. Feedback loop 1 is started up. Feedback 1 serves a pulling force and has the potential to turn the local economy from a low level to a growth pattern. Construction of formal and big infrastructures not only increase the infrastructure service levels but also job opportunities to the local community, but also create job opportunities in this region.

Yet, due to the duality, the effectiveness of this pulling force is reduced. The local economy may be boomed for a short-term. Yet, the vicious cycle is very difficult to be broken through. Meanwhile, infrastructure construction accelerates the depletion of natural resources, which potentially strengthens the vicious cycle.

Through the feedback analysis, it is proposed that further development strategies should first focus on the development of the local infrastructures and the improvement of the natural resources. The construction of the local infrastructures not only generates more job opportunities than the big infrastructure (ILO 1998), but also improve the infrastructure service level to the local rural communities more rapidly and effectively. Although the improvement of the natural resources can not really break the vicious cycle, it provides a good foundation for further development policies and avoids the risks of the natural disasters on the big infrastructures.

This study is based on the feedback analysis. A simulation computer model should be built for validate this qualitative analysis and confidence is obtained after the validation. Experimentation with this computer model enables the exploration of policies and policy packages.

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